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The effect of prolonged immobilization on elbow range of motion in supracondylar humerus fractures treated with closed reduction and percutaneous pinning

Prolonged immobilization and range of motion relationship

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Abstract
Aim: The purpose of this study was to evaluate the effect of prolonged immobilization on elbow range of motion in Gartland type III supracondylar humerus fractures treated with closed reduction and percutaneous pinning.
Material and Methods: In this retrospectively designed study, patients whose k-wires and cast were removed after sufficient callus tissue was visible were classified as Group A, and patients who had k-wires removed and arm casts used for more than 2 weeks prolonged were classified as Group B. All patients had Gartland type III supracondylar humerus fracture. Clinical outcomes of two patient groups were analyzed and compared.
Results: The final analysis included 72 patients. Group A consisted of 37 patients. Group B consisted of 35 patients. Group B had a significantly lower ROM than Group A in the second month ($p< 0.001$). Group B had a significantly lower ROM than Group A in the third month ($p=0.004$). There was no significant difference in ROM between Group A and Group B in the sixth ($p=0.48$) and twelfth months ($p=0.54$).
Discussion: In this study, there was no significant difference in ROM between patients who used long-arm casts for two weeks after their pins were removed and those who started mobilization early. Some patients may have to use long arm casts for a more extended period of time. However, it should be kept in mind that early rehabilitation reduces elbow contracture.

Keywords
Supracondylar, Humerus Fracture, Gartland Type 3, Prolonged immobilization

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Introduction

Supracondylar humerus fractures (SHF) are the most common elbow fractures in children. They are more common in children aged 5-8 years, with an annual incidence of 177.3 per 100.000 cases. (1) Supracondylar humerus fractures are more common in boys than in girls. (2) Falls are the most common cause of supracondylar humerus fractures because falling on an outstretched hand with an extended arm leads to hyperextension of the elbow, resulting in a supracondylar humerus fracture.

The Gartland classification system is used to choose the ideal treatment for SHF. (3) Surgery is one of the first methods of choice to treat displaced SHF (Gartland type II-IV and flexion type). The goal of surgery is to restore the normal elbow range of motion (ROM) and the carrying angle. (4)

Closed reduction and percutaneous pinning are standard treatments of SHF for three reasons. It protects soft tissues from trauma, causes few complications, and yields positive health outcomes. (5) There is no standard time to remove the pins. They are removed after 3-6 weeks after the callus tissue becomes visible. However, removal of pins in patients with prolonged immobilization takes 5-8 weeks, depending on patient factors (pain, anxiety, or nonadherence to post casting instructions). (6)

Elbow contracture is a common post-SHF complication. (7) There is a correlation between post-SHF elbow contracture and prolonged postsurgical casting. (8) This study compared the clinical outcomes of two patient groups. The sample consisted of patients treated with closed reduction and percutaneous pinning for SHF. The first group consisted of patients who used casts for two weeks after pin removal. The second group consisted of patients who did not use casts after pin removal. The research hypothesis was as follows: "ROM is more limited in patients with prolonged immobilization in long arm casts."

Material and Methods

The study was approved by the institutional review board. The study retrospectively analyzed the clinical outcomes of patients treated with closed reduction and percutaneous pinning (divergent-lateral pins) between 2018 and 2020 for SHF (Gartland type III). The exclusion criteria were (1) Gartland-type II and flexion-type fractures, (2) early reoperation due to complications, (3) pathological fractures, (4) metabolic bone disease, and (5) other percutaneous pinning methods, such as cross pinning.

The same surgical team operated on all patients between 2018 and 2020. All patients underwent closed reduction and divergent lateral pinning. The sample was divided into two groups: (1) patients who started ROM rehabilitation after their pins were removed after the callus tissue became visible (Group A) and (2) patients who used long arm casts for two weeks after their pins were removed (Group B). The pins were removed in the outpatient clinic. All patients were followed up for 12 months. Their Month 2, Month 3, Month 6, and Month 12 elbow ROM grades and Flynn class ROM (12th month) were compared. Complications were recorded. Table 1 shows Flynn's criteria (9) for outcomes.

The elbow carrying angle, extension and flexion, lower arm rotation, and shoulder external rotation on both arms were recorded. The carrying angle is the angle between the upper and lower arm when the elbow is entirely straight. The carrying angle was measured using a goniometer. The lower arm rotation was measured as degrees of supination and pronation from the neutral position when the elbow flexed at 90 degrees. Maximum external rotation in the shoulder was measured when the glenohumeral joint was in the neutral position in the sagittal and frontal plane and the elbow flexed at 90 degrees.

Data analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, v. 15.0) at a significance level of 0.05. All patients admitted to the hospital between 2018 and 2020 were included in the sample. Mean and standard deviation was used for descriptive statistics. The Mann–Whitney U test was used to compare the two groups.

Results

The sample consisted of 72 patients with Gartland type III SHF. Group A consisted of 22 boys (59.4%) and 15 girls (40.6%) with a mean age of 6.54 years (min: 2 and max: 12). Group B group consisted of 20 boys (57.1%) and 15 girls (42.9%) with a median age of 6.17 (min: 2 and max: 11). The two groups were homogenous in terms of age and gender (Table-2).

In Group A, the pins were removed between days 21 and 36 (median: 26). In Group B, the pins were removed between days 30 and 33 (median: 28). There was no significant difference in pin removal times between the groups (p=0.61).

Group B had a significantly lower ROM [80 (45°-145°)] than Group A [110° (65°-150°)] in the second month (p< 0.001). Group B had a significantly lower ROM [110° (80°-150°)] than Group A [120° (95°-150°)] in the third month (p=0.004). There was no significant difference in ROM between Group A [145° (110°-150°)] and Group B [120° (100°-150°)] in the sixth month (p=0.48) There was no significant difference in ROM between

Table 1. Flynn's Criteria

Result	Rating	Cosmetic factor: carrying angle (°)	Functional factor: motion loss (°)
Satisfactory	Excellent	0-5	0-5
	Good	>5-10	>5-10
	Fair	>10-15	>10-15
Unsatisfactory	Poor	>15	>15

Table 2. Demographics

	Group A	Group B	p-value
Age (mean, range)	6.54(2-12)	6,17(2-11)	0.55
Gender (N)			
Male	22	20	0.84
Female	15	15	
Pin removal time (days)	26 (20-33)	28 (21-36)	0.61

Table 3. Follow-up ROM Degrees

	Group A	Group B	p-value
ROM (Month 2)	110° (65°-150°)	80 (45°-145°)	<0.001
ROM (Month 3)	120° (95°-150°)	110° (80°-150°)	0.004
ROM (Month 6)	145° (110°-150°)	120° (100°-150°)	0.48
ROM (Month 12)	150° (120°-150°)	150° (120°-150°)	0.54

Group A [150° (120°-150°)] and Group B [150° (120°-150°)] in the twelfth month (p=0.54). There was no significant difference in outcomes between the type of treatment groups about four categorical groups according to Flynn's classification for the cosmetic outcome (carrying angle) (p=0.22). There was no significant difference in the outcome between the groups (p=0.22) and the functional outcome (ROM) (p=0.34).

Discussion

Supracondylar humerus fractures (SHF) are the most common elbow fractures in children, accounting for about 12-17% of all pediatric fractures. (10) SHF are associated with a high risk of short- and long-term complications due to injury and treatment. Medial and lateral crossed pinning and lateral pinning (using two pins) are the two most common fixation techniques for treating SHF. Although numerous researchers have compared the surgical outcomes of those two techniques, (11) their results have been inconclusive. Therefore, surgeons prefer either one or the other, depending on their experience and skill levels. Lee et al. found that four in ten pediatric orthopedic surgeons preferred the lateral pinning technique. (12) We also prefer to use lateral pinning to treat SHF in our clinic.

When we observed enough callus tissue on the radiograph, we removed the pins between the third and fifth weeks in accordance with the literature. (13) In our clinic, we remove pins as early as possible because post-SHF infections are associated with the pin tract. (14) We removed all pins in the polyclinic because it is a safe procedure that does not cause too much pain. (15,16)

In the case of pain, low cognitive activity and parental anxiety, patients used long arm casts for two more weeks. When we analyzed the data retrospectively, we observed that about half the patients underwent prolonged immobilization in long arm casts.

Patients with early elbow mobilization (active-assisted or passive) are likely to have better articular homeostasis and ROM and a lower prevalence of edema and hematoma. (17)

Patients who start post-immobilization rehabilitation early are more likely to get their elbow function back to normal. Therefore, starting rehabilitation too late may have adverse effects, such as loss of ROM, strength, and function. Full recovery of elbow injuries depends on early physical therapy intervention. (18)

Group B had more limited early joint movements than Group A. However, there was no significant difference in joint movements between the two groups in the sixth and twelfth months. This result shows that some patients should use long arm casts longer for a full recovery.

The groups had similar complication rates. There is no research indicating a negative correlation between prolonged use of long arm casts and complications.

This study had three limitations. This study was retrospective that might have been subject to selection and information bias. Second, the sample size was relatively small. Third, patients were followed up for a short period. The last two limitations might have prevented us from detecting axial and sagittal plane deformities.

Conclusion

In conclusion, our results did not show a significant difference in ROM between patients who used long arm casts for two weeks after their pins were removed and those who started mobilization early. Some patients may have to use long arm casts for a more extended period of time. However, it should be kept in mind that early rehabilitation reduces elbow contracture.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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References

1. Mulpuri K, Wilkins K. The treatment of displaced supracondylar humerus fractures: evidence-based guideline. J Pediatr Orthop. 2012;32 (Suppl. 2):S143-52.

2. Kasser JR, Beaty JH. Supracondilar fractures of the distal humerus. In: Beaty JH, Kasser JR, editors. Fractures in children. 5th ed. Philadelphia: Lippincott Williams &Wilkins; 2001. p. 577–624.

3. Abzug JM, Herman MJ. Management of supracondylar humerus fractures in children: current concepts. J Am Acad Orthop Surg. 2012;20(2):69-77

4. Tuomilehto N, Sommarhem A, Nietosvaara AY. 9 years' follow-up of 168 pin-fixed supracondylar humerus fractures in children. Acta Orthop. 2018;89(3):351-6.

5. Bhuyan BK. Close reduction and percutaneous pinning in displaced supracondylar humerus fractures in children. J Clin Orthop Trauma. 2012;3(2):89-93.

6. Karalius VP, Stanfield J, Ashley P, Lewallen LW, DeDeugd CM, Walker J, et al. The Utility of Routine Postoperative Radiographs After Pinning of Pediatric Supracondylar Humerus Fractures. J Pediatr Orthop. 2017;37(5):e309-12.

7. Jersek S, Sambuljak A, Zerjavic-Kunic V. O rehabilitaciji djece s ozljedom lakta [Rehabilitation of children with elbow injuries]. Reumatizam. 1987;34(1-6):41-3.

8. Celiker O, Pestilci FI, Tuzuner M. Supracondylar fractures of the humerus in children: analysis of the results in 142 patients. J Orthop Trauma. 1990;4(3):265-9.

9. Flynn JC, Matthews JG, Benoit RL. Blind pinning of displaced supracondylar fractures of the humerus in children. Sixteen years' experience with long-term follow-up. J Bone Joint Surg Am. 1974;56(2):263-72.

10. Khoshbin A, Leroux T, Wasserstein D, Wolfstadt J, Law PW, Mahomed N, et al. The epidemiology of paediatric supracondylar fracture fixation: a population-based study. Injury. 2014;45(4):701-8.

11. Foead A, Penafort R, Saw A, Sengupta S. Comparison of two methods of percutaneous pin fixation in displaced supracondylar fractures of the humerus in children. J Orthop Surg (Hong Kong). 2004;12(1):76-82.

12. Lee SS, Mahar AT, Miesen D, Newton PO. Displaced pediatric supracondylar humerus fractures: biomechanical analysis of percutaneous pinning techniques. J Pediatr Orthop. 2002;22(4):440-3.

13. Kropelnicki A, Ali AM, Popat R, Sarraf KM. Paediatric supracondylar humerus fractures. Br J Hosp Med (Lond). 2019;80(6):312-16.

14. Mehlman CT, Crawford AH, McMillion TL, Roy DR. Operative treatment of supracondylar fractures of the humerus in children: the Cincinnati experience. Acta Orthop Belg. 1996;62 (Suppl. 1):S41-50.

15. Sorenson SM, Hennrikus W. Pain during office removal of K-wires from the elbow in children. J Pediatr Orthop. 2015;35(4):341-4.

16. Symons S, Persad R, Paterson M. The removal of percutaneous Kirschner wires used in the stabilisation of fractures in children. Acta Orthop Belg. 2005;71(1):88-90.

17. Fusaro I, Orsini S, Stignani Kantar S, Sforza T, Benedetti MG, Bettelli G, et al. Elbow rehabilitation in traumatic pathology. Musculoskelet Surg. 2014;98 (Suppl. 1):95-102.

18. Murtezani A, Pustina A, Bytyçi C, Hundozi H. Rehabilitation of children after elbow injuries. Niger J Med. 2007;16(2):138-42.

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